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EFFECT OF SURFACTANTS ON PLANT DISEASE MANAGEMENT

Amitava Mondal, Supratim Sadhu, and Anjan Dhali

Faculty of Agriculture, JIS University, Agarpara, Kolkata-700109, West Bengal, India

*Corresponding author email: amitava435.am@gmail.com

ABSTRACT

Volatile organic compounds (VOCs) are crucial plant responses to biotic and abiotic stimuli, emitting signals that convey the physiological state of the plant. Research on plant-plant interactions primarily focuses on defensive reactions in recipient plants, but VOCs also influence hormone communication and metabolism, affecting overall plant fitness. This summary highlights how VOC exposure impacts receiving plants, detailing key chemical cues, VOC absorption, conversion, and surface adsorption. Significant changes in growth, reproduction, and metabolism are discussed, emphasizing the need for further research on whole plant responses to fully understand VOC effects.

KEYWORDS: Disease management, Spreading property, Surfactant solution

INTRODUCTION

Surfactants help transfer pesticide compounds to their intended targets in plants, vectors, or diseases more easily. They are typically employed in conjunction with pesticides in plant disease management. Surfactants are an essential or fundamental part of various consumer and industrial formulations. Such organic amphiphilic molecules show exclusive potency to adsorb in aqueous or non-aqueous solution at the self-aggregate, self-assemble, interface, or in different phases. Surfactants may not only effectively reduce the surface tension of the solution but also dissolve the epicuticular waxes on the leaf surfaces. Effective agrochemical spraying on plants and seeds and minimum wastage is an important issue with respect to crop yield, storage, and mitigation of environmental pollution. Most agrochemicals are applied as liquids sprayed through nozzles and the volume ranges from 1000 to 1 litre per hectare and droplet diameter varies from 50 to 400 µm. In agrochemical applications, parameters such as droplet size, their impact and adhesion, spreading, and retention are of primary importance in ensuring maximum capture by and adequate coverage of the target surface.

Recently, Smith, Askew, Morris, Shaw, and Boyette studied in great detail the effect of droplet size and leaf morphology on pesticide spraying and deposition. Young, Thacker and Curtis studied the effect of three adjuvants on the retention of insecticide on cabbage leaf based on the physical properties of the formulation e.g., static surface tension and viscosity. The spreading velocity is often an important criterion based on which the efficiency of surface-active substances (surfactants) can be estimated. In general, when a liquid drop is placed on a solid surface, either it spreads over the surface, that is, it completely wets the surface or it forms a finite contact angle with the surface. If the contact angle is between 0° and 90°, the situation is referred to as partial wetting. However, if the contact angle is larger than 90°, the liquid does not wet the surface and the situation is referred to as non-wetting (Fig. 1).

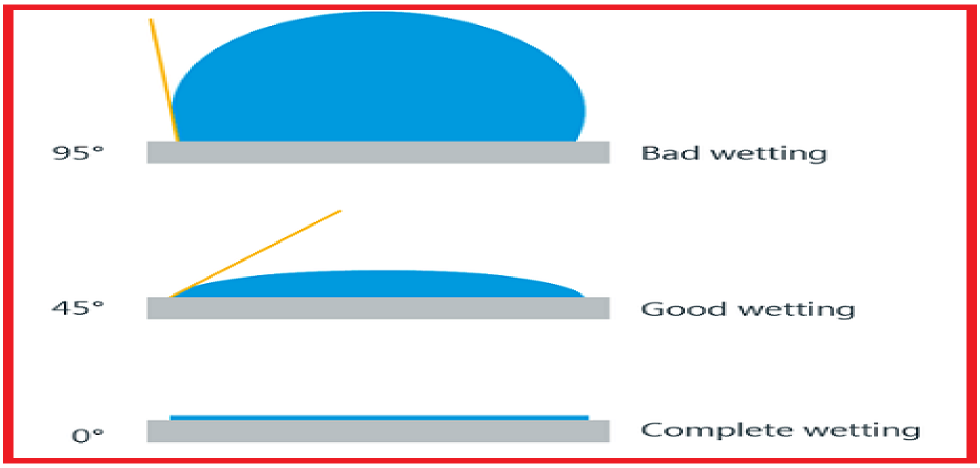

Fig. 1. Different wetting situations. (a) Complete wetting case: a droplet completely spreads out and only a dynamic contact angle can be measured, which tends to zero; (b) Good wetting case: the final static advancing contact angle is between 0° and 45°; (c) Bad wetting case: contact angle is larger than 90°.

SPREADING OF AQUEOUS SURFACTANT SOLUTIONS ON HYDROPHOBIC SURFACES

Most of the natural and artificial surfaces are poorly wetted or are not wetted at all by water and aqueous solutions (Fig. 2). These surfaces are referred to as low-energy surfaces or hydrophobic surfaces. These surfaces are referred to as low-energy surfaces or hydrophobic surfaces. However, various technological processes require aqueous solutions to spread out on originally hydrophobic surfaces (Tadros, 2005).

SPREADING

Many leaf surfaces are non-wettable by nature. This is due to the predominantly hydrophobic nature of the leaf surface, which is usually covered with crystalline wax of straight chain paraffinic alcohols in the range of 24–35 carbon atoms. In agrochemical application it is important to cover the leaf surface with a minimum quantity of liquid i.e., thickness of the film of the agrochemical should be small.

It is seen that the spreading factor for water increases with the addition of tergitol, which is non-ionic, the compared with the ionic surfactants HTAB and SDBS.

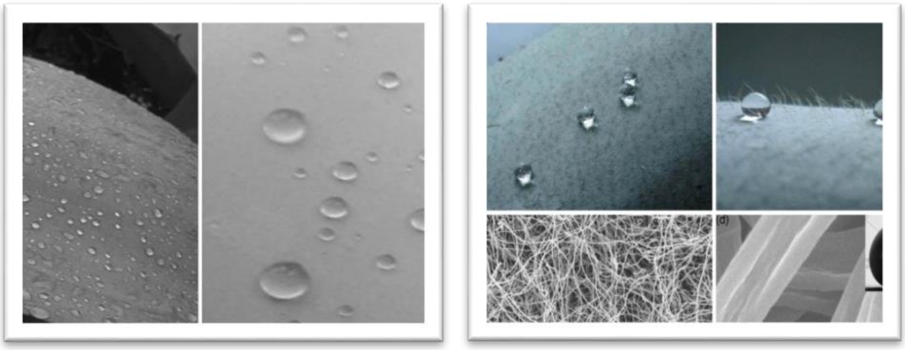

Fig. 2. Rain droplets on the leaf of an Agavaceae plant (left). Water droplets deposited from a sprayer on the surface of a polypropylene film (right) (Ivanova and Starov, 2011).

BIMODAL KINETICS OF SPREADING OF SURFACTANT SOLUTIONS

One of the widely used methods to analyse the mechanism of spreading of surfactant solutions is to fit the experimental data by the power law R ~ tn. This method is widely used to analyse wetting by pure liquids. Briefly, the relationship between the spreading/power exponent, n, and the corresponding mechanism is as follows. In the case of small droplets and complete spreading, n = 0.1 (Tanner's law), showing the capillary-driven spreading regime (Tanner, 1979), or n = 0.14, the same regime but based on a molecular approach to the dissipation of energy. Svitova et al., 2001 reported that, two stages of complete spreading of C12EO3 surfactants and trisiloxanes TEO8 and TEO12 on graphite. For polyoxyethylene alcohols at C > cac (cac is the critical aggregation concentration; critical wetting concentration > cac) the first and second stages were described by the power laws with n = 0.1 and n = 0.4, respectively. In the case of trisiloxanes at C > cwc the authors found higher spreading exponents: n = 0.2 and n = 0.5, respectively. Only one-stage partial wetting was observed for both types of surfactants at C < cmc/cwc.

Some authors do not report the bimodal kinetics of spreading of the surfactants studied, but they provide the evolution of the spreading exponents with concentration (Zhang et al., 2009), which is useful for the identification of the driving forces responsible for spreading in a certain concentration range of surfactants.

SURFACTANTS USED IN DIRECT PLANT DISEASE CONTROL

The use of the non-ionic surfactant Agral 90 to inactivate the zoospores of Olpidium brassicae, the vector of the big vein virus of lettuce and the melon necrotic spot virus of cucumber, was one of the early investigations demonstrating the effects of surfactants on a plant pathogen (Jibrin et al., 2021). It was assumed that the disease reduction in lettuce was caused by adding the fungicide benzimidazole to the recirculating nutrient solution of a hydroponic system, therefore this initial discovery was fortunate. More proof that surfactants are effective against zoospores comes from recent research. Within one minute of being exposed to 10 µg/ml of the alkoxylate non-ionic surfactant Atplus MBA1301, zoospores of Phytophthora cryptogea, the agent responsible for brown root rot of witloof chicory, exhibited both lysis and motility inhibition. Plant bacterial infections have been demonstrated to be exacerbated by the non-ionic organosilicon surfactant Silwet L-77, which is extensively utilised in field crop production (Brosset and Blande, 2022).

CONCLUSIONS

Wetting and spreading phenomena occurring in the presence of non-ionic surfactants on hydrophobic solids and thin aqueous layers are reviewed. Special attention is paid to wetting/spreading/penetration of non-ionic hydrocarbon and organosilicon surfactants that are widely used in industrial and scientific applications. In the presence of a small quantity (0.1 wt.%) of tergitol in water, the static contact angle decreases and thus the adhesion ((Eo - Es)/Es), spreading factor, and surface coverage factor of droplets on all the leaf and seed surfaces increases. The effects of surfactants on the plant microbiome, the lowest level of harmful pesticide residue, and their application in improving plant disease control are all poorly understood. The next step in enhancing plant disease management and guaranteeing environmental safety is anticipated to involve investigating green surfactants and other biosurfactants and incorporating them into chemical plant disease control.

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HARNESSING DRONE TECHNOLOGY FOR SUSTAINABLE AGRICULTURE: ADDRESSING CHALLENGES AND OPPORTUNITIES

Chalapathi Rao Gadde[1]and Navya Sri Adapa[2]

[1]M. Sc scholar, Agronomy, Agricultural College, Bapatla, ANGRAU, Andhra Pradesh

[2]B. Sc scholar, Agricultural College, Rajamahendravaram, ANGRAU, Andhra Pradesh

Corresponding author email: gaddechalpathirao23@gmail.com

ABSTRACT

As global food demand rises with a growing population, drones are revolutionizing agriculture by enhancing precision and efficiency. This article examines how drones improve farm analysis, seed planting, crop monitoring, and spraying. Benefits include increased efficiency, reduced pesticide waste, and cost savings, while challenges such as limited flight time and high initial costs persist. The article also reviews drone regulations in India and suggests policy improvements to support drone integration in agriculture. Ultimately, drones offer significant potential to address labour shortages and boost global food security.

KEYWORDS: Crop monitoring, Crop surveillance Precision agriculture, Remotely piloted aircraft systems

INTRODUCTION

As the global population is projected to reach 9 billion by 2050, the demand for agricultural production will increase dramatically. This growth highlights the need to address challenges such as labour shortages in the agriculture sector, which is vital for global food security. Modern farming increasingly relies on precision agriculture techniques that utilize data and technology for better crop management and cost efficiency. Drones, or Remotely Piloted Aircraft Systems (RPAS), have emerged as a revolutionary tool in this domain. With capabilities such as automated flight planning and payload handling, agricultural drones significantly enhance efficiency and reduce the need for manual labour, offering a transformative approach to modern farming.

BASIC PRINCIPLE - HOW DO DRONE WORK?

Drones, typically quadcopters, have four vertically oriented propellers with independent speeds, enabling a range of movements. Key components include:

- *Chassis:* The drone's frame, balancing strength and weight to support additional components like cameras.
- *Propellers:* Affect load capacity, flight speed, and manoeuvrability. Longer propellers provide greater lift at lower speeds, while shorter propellers offer quicker speed changes but require higher rotation speeds, potentially reducing motor lifespan.
- *Motors:* Each propeller has a motor rated in "kV" (revolutions per minute per volt). Higher motor speeds increase flight power but reduce battery life.
- *Electronic Speed Controller (ESC):* Regulates current to each motor to control speed and direction.
- *Flight Controller:* The onboard computer that processes pilot signals and directs the ESC.
- *Radio Receiver:* Receives control signals from the pilot.
- *Battery:* Typically, lithium polymer, known for high power density and recharging capability.

Additional sensors, such as accelerometers, gyroscopes, GPS, and barometers, aid in navigation, while cameras assist with visual and data capture.

DRONE MECHANISM - HOW DO YOU FLY A QUADCOPTER DRONE?

Drones can be manually controlled via a handheld radio transmitter, which adjusts propeller speeds using joysticks and trim buttons for balance. Screens may display live video from the on-board camera and sensor data. Drones can also fly autonomously by following GPS waypoints programmed into modern flight controllers.

APPLICATIONS OF DRONES IN AGRICULTURE SECTOR

- *Farm Analysis:* Drones can create 3D soil maps, helping farmers assess soil conditions and manage irrigation and nitrogen levels for better crop growth.
- *Seed Pod Planting:* Some drones are equipped to shoot seed pods and nutrients into prepared soil, reducing planting costs.
- *Crop Monitoring:* Drones use multispectral data to monitor crop health and development, offering early warnings through data analytics before issues become visible.
- *Crop Spraying:* Drones with reservoirs can efficiently spray fertilizers and pesticides over large areas, improving efficiency by up to five times and minimizing human contact with chemicals.
- *Irrigation:* Drones with thermal or multispectral sensors detect moisture deficits in fields, allowing for precise and timely irrigation planning.
- *Crop Health Assessment:* Drones equipped with sensors can track crop health over time by analysing visible and near-infrared light, monitoring plant stress and response to treatments.

- *Crop Surveillance:* Drones with infrared cameras provide detailed, real-time maps of field conditions, aiding in crop management and insurance claim verification.
- *Weed, Pest, and Disease Control:* Drones can detect and report areas affected by weeds, pests, and diseases, helping farmers optimize chemical use and improve field health.
- *Biomass Estimation:* LiDAR-equipped drone's measure canopy density and height changes to estimate tree or crop biomass, aiding in timber and crop production estimates.
- *Bird Scaring:* Drones can effectively scare birds away from fields, reducing the need for manual labour to protect crops.

BENEFITS OF DRONES USAGE IN AGRICULTURE

- *Enhanced Security:* Agriculture sprayer drones are operated remotely by trained pilots, eliminating the need for farmers or farm workers to handle hazardous chemicals and face challenging conditions directly.
- *Increased Efficiency and Field Capacity:* Drones have minimal turnaround time and operational delays. Depending on their capacity, drones can cover 50-100 acres in a day, which is about 30 times more efficient than traditional knapsack sprayers.
- *Reduced Pesticide Waste:* The advanced atomization technology used by drones conserves up to 30% of pesticides. They can deliver pesticides as a fine mist at all crop levels, minimizing waste.
- *Water Conservation:* Using ultra-low volume spraying technology, drones save up to 90% of water compared to traditional spraying methods.
- *Cost Efficiency:* Drone-based spraying is significantly cheaper, reducing costs by 97% compared to conventional spraying techniques.
- *User-Friendly and Low Maintenance:* Agricultural drones are built to be durable, with low maintenance costs and a long operational life. Parts are easy to replace, making them simple to manage for service providers.

LIMITATIONS OF DRONES FOR AGRICULTURAL USAGE

- *Flight Time and Range:* Due to relatively higher payloads, the flight duration of drones used in agriculture is short, ranging from 20-60 minutes. This results in limited coverage of land with every charge. The cost of drones increases significantly with longer flight time.

- *Initial Cost:* Mostly, agricultural drones are costlier as it includes cost of imaging sensors, software, hardware and tools. The initial cost is also proportional to the payload and flight duration capacities, apart from sensors and features included.
  - *Connectivity:* Online coverage is mostly unavailable in the arable farms. Under such a situation, any farmer intending to use drones has to invest in connectivity or buy a drone with local data storing capability in a format that can be transferred and processed later.
  - *Weather Dependent:* Under windy or rainy conditions, flying drones is not easy, unlike traditional aircrafts. Drones are weather dependent.
  - *Knowledge and Skill:* An average farmer cannot analyse the drone images as it requires specialized skills and knowledge to translate it to any useful information. Under these circumstances, the farmer has to acquire the skills and knowledge of software of image processing or hire skilled personnel conversant with the analysis software.
  - *Misuse:* There is a chance of misuse to infringe the privacy of people and illegal transfer of information.

GENERAL INDIA DRONE LAWS

Several drone laws that need to be followed when flying in the country. Operators must ensure that they follow the following drone laws when flying a drone that weighs over 250 grams in India.

- *Support for Drone Entrepreneurs:* Offer expedited registration and targeted training on regulations for entrepreneurs involved in drone services.
- *Expedited Drone Registration:* Reopen and fast-track the drone registration process with the Directorate General of Civil Aviation (DGCA), especially considering the disruptions caused by the COVID-19 lockdown.
- *Affordable Drone Training for Agriculture:* Ensure that training programs for agricultural drone operators are both accessible and cost-effective for emerging entrepreneurs. Integrate this training into the agricultural degree programs and align it with DGCA standards.
- *Incorporation of Drone Licensing in Pesticide Legislation:* Include DGCA guidelines for issuing licenses or certifications for drone operators in pesticide spraying within the updated Pesticides Management Bill, 2017.
- *Use of Existing Pesticide Formulations with Drones:* Permit the use of current pesticide formulations, as specified on their labels, in drone-based applications. Ensure that regulations for consistent pesticide coverage in crops are included in the Pesticides Management Bill, 2017.

- *Insurance for Drone-based Pesticide Application:* Provide for liability and damage insurance related to drone pesticide applications in the Pesticides Management Bill, 2017.
- *Development of BIS Standards:* Create Bureau of Indian Standards (BIS) guidelines to benchmark drone specifications for agricultural purposes and establish testing and evaluation criteria for these applications.
- *Enhancing Testing Facilities for Drones*: Upgrade Farm Machinery Testing Centres to include capabilities for testing and assessing agricultural drone applications, ensuring they meet BIS standards.
- *Establishment of Drone Corridors with UTM:* Designate specific airspace for drones, including the implementation of unmanned traffic management (UTM) systems to facilitate safe and orderly drone operations.

CONCLUSION

Drone technology offers essential solutions to meet the growing global food demands and alleviate labour shortages in agriculture. By enhancing precision in crop management, monitoring, and spraying, drones reduce manual labour and operational costs. While challenges such as limited flight time and high initial costs exist, the benefits of improved efficiency, accuracy, and sustainability make drones a valuable asset in modern farming. With continuous advancements and supportive policies, drones are poised to significantly transform agricultural practices and contribute to global food security.

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SMART FIELDS: SUSTAINABLE FARMING THROUGH IoT

Devendra Kumar Dadhich[1]*, Rohit Yadav[1], Sougata Roy[2], and Krishna[1]

ICAR-National Dairy Research Institute 1, Karnal, Haryana 132001

International Potato Centre (CGIAR-CIP)2 Patna, Bihar 800014

*Corresponding author email: devdadhich098@gmail.com

ABSTRACT

Global increasing population is driving a change to more intelligent agricultural methods. Food security is a serious worry for most nations due to an increase in unpredictable weather patterns, dwindling natural resources, and a shortage of arable land. Consequently, the agricultural industry is using the Internet of Things (IoT) to boost production and operational efficiency. This article discusses the use of various IoT devices and the advantages they offer over conventional farming techniques. It also identifies the challenges and limitations of these devices in agriculture.

KEYWORDS: Agricultural drones, Farming techniques, Food security

INTRODUCTION

Sustainable agriculture makes it feasible to promote farming practices and strategies that maintain the sustainability of farmers and resources. Over time, India's total agronomic output has increased, while the country's share of farmers has declined, from 71.9% in 1951 to 42.3% in 2024. According to the 2018 Economic Survey, in 2050, the percentage of workers in agriculture will fall to 25.7% of the overall employment. Since the world is about to experience a digital revolution, now is the right moment to introduce and facilitate digital communication with farmers by using wireless technology to link the agricultural landform. IoT-based smart agriculture technology offers several benefits for all agricultural operations and procedures in real-time, such as plant protection, fertilization, irrigation, disease prediction, and improvement in product quality. Farmers may use the exact field view provided by today's sensor and communication technology to identify ongoing field operations without physically being there. Use of wireless sensors for different field operations provide higher resource use efficiencies, yields; accurate agricultural monitoring and early problem detection, thus protect from crop failures, save time and resources.

IoT IN AGRICULTURE

The Internet of Things (IoT) in agriculture refers to a network of physical objects embedded with electronics, software, sensors, and connectivity, which enables these objects to collect and exchange data. This concept builds on historical advancements, from 19th-century steam engines to 20th-century robotics and programmed machinery, evolving into the current era where big data, artificial intelligence, and IoT devices are revolutionizing farming practices. IoT leverages mobile devices, cloud-based intelligence, sensors, smart objects, and communication infrastructure to facilitate decision-making.

APPLICATIONS OF IOT IN AGRICULTURE

IoT technologies can be used for different purposes in agriculture such as for soil mapping and plant monitoring, irrigation management, weed management, crop protection, site-specific nutrient management, yield monitoring and forecasting etc.

A. Soil mapping and plant monitoring: Today, farmers can track the quality of their soil and take appropriate action to prevent soil degradation caused by erosion, alkalization, acidification, salinization, and pollution by using a variety of sensors and tools that monitor soil properties like water-holding capacity, texture, and absorption rate. Farmers can use sensors and mobile devices to monitor soil and ambient factors like leaf wetness, temperature, humidity, and crop quality from sowing to harvest, emphasizing the interplay between soil, plant, and environment for maximum agricultural output.

B. Smart irrigation management: - Predictions utilizing the irrigation index values may be employed for every field depending on slope or soil variability to increase water consumption efficiency. Information from sensors, satellite imagery, and climate data are coupled to the CWSI (crop water stress index) model for water need computation. Sensor based analysis of crop water requirements provide real time values that can be correlated with application amount.

C. Site-specific nutrient management: - Utilizing site-specific soil nutrient fertilization, smart agriculture reduces environmental effect while precisely estimating nutrient levels. Measurements are influenced by several factors such as crop type, soil type, yield objectives, and fertilizer type. Nutrient distribution patterns are estimated via IoT-based fertilizing strategies. This strategy makes use of satellite imagery as well as technology like GPS, geotagging, and driverless cars. Two efficient methods of management are chemigation and fertigation.

D. Agricultural Drones: **-** In smart farming using IoT, drones are being utilized to enhance a number of agricultural processes. Aerial-based and Surface-based are the two categories of agricultural drones. They are used in tasks including crop health assessment, spraying, irrigation, crop monitoring, soil and field analysis

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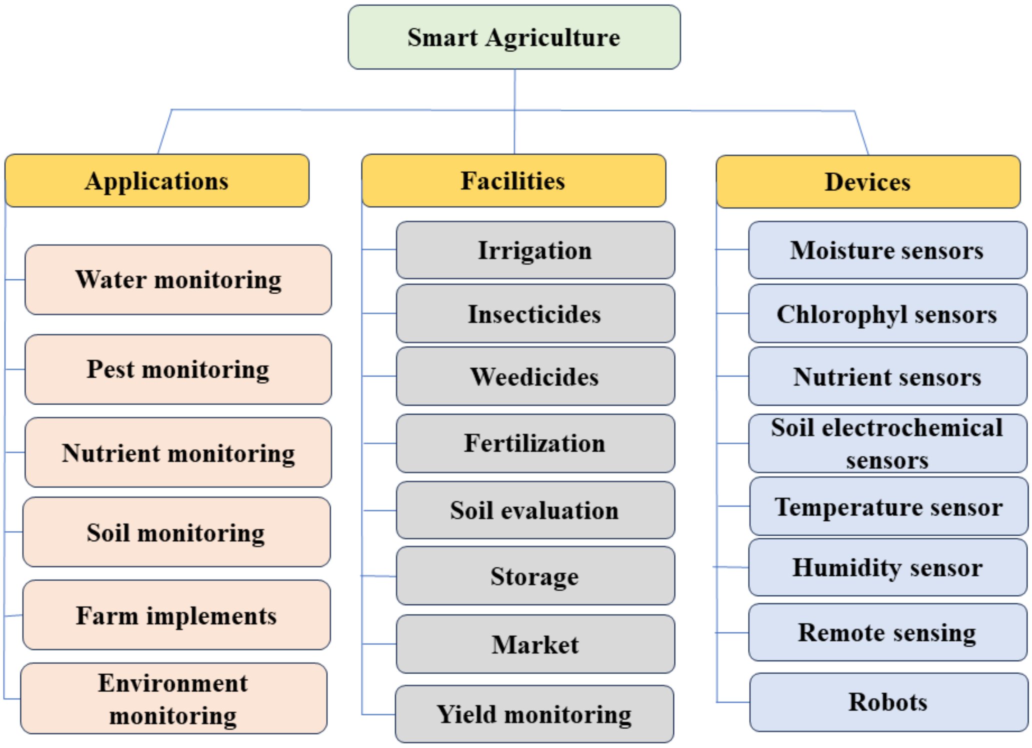

Figure 1: Overview of Smart Agriculture: Applications, Facilities, and Devices

E. Crop yield prediction and price forecast: Crop forecasting helps farmers with future planning and decision-making by predicting output before harvest. By observing characteristics like as fruit size and color, maturity establishes the ideal time for harvesting. Accurately determining when to harvest is essential to maximize crop yield and quality. A harvester's yield monitor that is linked to a smartphone app provides real-time harvest statistics and sends information to a web platform. Satellite pictures are used to assess fruit conditions and market potential, as well as to estimate and monitor agricultural productivity, especially for fruit crops.

F. Crop surveillance: Use of remote sensing, In-field sensors, IoT devices, data analytics and GIS (Geographic information systems) for monitoring insect pest infestation, disease diagnosis, nutrient deficiencies and other factors that can affect crop productivity. IoT enables surveillance of the crops by the farmers without physical presence.

G. Livestock monitoring and management: Use of location sensors by tying them to the neck or feet of the animal. These devices, with the help of satellites, continuously provide location data to the owner on the mobile phone. Automated cleaning, feeding, and milking systems for cattle are made possible by IoT devices. Estrus, body temperature, rumen pH, and temperature are all detectable via sensors.

BENEFITS OF IoT IN AGRICULTURE

- Increased productivity and efficiency: IoT devices provide real-time data related to several parameters such as soil moisture, air and crop temperature, nutrient deficiency, pest and disease infestation on crop etc., thus on time management strategies can be applied which ultimately improve overall efficiency of the resources and productivity of the crops.
- *Resource optimization:* Reliable data produced by the sensors can be used for calculation of actual quantity of resources required by the crop. Wastage of water, fertilizers, pesticides and others can be minimized with real-time estimation.
- *Enhanced decision-making:* Farmers become able to make decisions related to crop management practices based on climate, soil and crop data generated by the sensor embedded devices.
- *Reduced environmental impact:* Better management of the inputs (Right time, method, quantity, place and source) reduces the burden of chemicals on environment.
- *Improved crop quality and yield:* Early detection of the pests, diseases and nutrient deficiencies helps in timely adoption of control measures, yield data can be generated by mounting sensors on harvesters. Based on this data resources can be supplied accordingly with the help of GIS, remote sensing and GPS (Global positioning system) technologies.

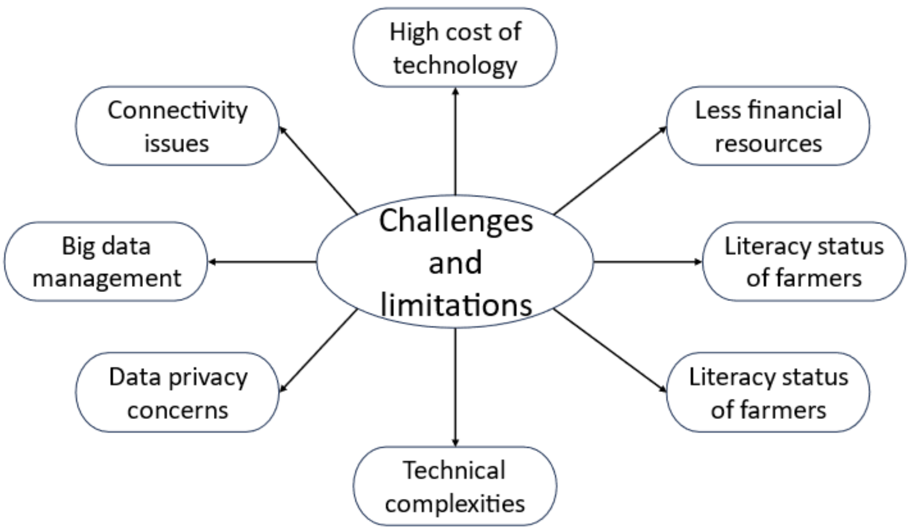

Figure 2: Key Challenges and Limitations in Smart Agriculture

CONCLUSION

World hunger is a pressing issue, and agriculture faces challenges like climate change and population growth. Innovative solutions like artificial intelligence (AI), IoT, and big data can revolutionize farming and increase production in poor countries. Technical breakthroughs and financial backing from organizations like governments, cooperatives, and FPOs can transform the agricultural industry, despite potential drawbacks like high prices and data management issues.

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TEMPERATE FRUITS ROOTSTOCK PROPAGATION: AN OVERVIEW

Shilpa*, Rimpika, and Ankita Sood

College of Horticulture and Forestry, Thunag, Distt. Mandi, Himachal Pradesh, India – 175048

Corresponding author email: shilpananglia1990@gmail.com

ABSTRACT

A concise overview of temperate fruit tree rootstock growth causes is provided, alongside key propagation techniques. Recently, attributes like pest and disease resistance, tolerance to adverse climates, and the ability to dwarf the scion have become more important than ease of propagation when selecting clonal rootstocks. This shift is due to advanced propagation methods that allow for the cultivation of resistant clones. However, these novel techniques can lead to partial rootstock renewal, and micropropagated rootstocks may show increased burr knotting and frequent suckering, presenting challenges in their use.

KEYWORDS: Budding, Cuttings, Grafting, Layering, Micropropagation, Propagation, Stooling

INTRODUCTION

The rootstock, or subterranean component of the plant, is where the desired cultivar's scion wood or bud is inserted through the processes of grafting and budding. As the name implies, rootstock is resilient and has a robust root system. Seeds and vegetative methods are both used to propagate rootstocks. Seedling rootstocks and eventually clonal rootstocks are the names given to stocks that are grown from seeds. Clonal rootstocks have a shorter lifecycle than the seedling rootstocks, but they function better. Prior to choosing a rootstock, one should be aware of all of its characteristics as well as the growing environment. Such rootstocks that are more likely to be able to tolerate the chilly winter temperatures should be considered for temperate fruit production. Many rootstocks have different characteristics, including resilience to cold, drought, salt, pests, and diseases. These characteristics affect the scion cultivars in different ways, such as tree vigor, precocity, and fruit size.

Most tree fruit species' cultivars have historically had poor root propagation, regardless of whether layering or cutting techniques are applied. While propagation studies conducted over the previous 15 years has made some of the issues related to having scions growing from their own roots (Jones et al. 1985), subpar cropping results, sucking, and burr knotting still show issues with trees that root themselves (Webster et al. 1985). All rootstocks were produced from seed at first. original fruit species were harvested from their original populations, and the seeds were removed, allowed to germinate, and then planted to serve as rootstocks. In many regions of Europe, there were plentiful wild populations of apples (*Malus domestica* Borkh.), pears (*Pyrus communis* L.), plums (*Prunus domesticica* L.), sweet cherries (Prunus avium L.), and sour cherries (Prunus cerasus L.). These days, a lot more focus is placed on the qualities of rootstocks, such as their capacity to dwarf scions and their resilience to diseases and pests carried by the soil. As a result, several rootstock clones that are challenging to propagate have been chosen. This has made it necessary to modify and enhance conventional rootstock propagation methods.

METHODS OF PROPAGATION OF ROOTSTOCKS

The primary techniques used for rootstock propagation is given in Table 1. Most rootstocks are cultivated from seed around the world, but more and more clonal rootstocks are being utilized to propagate varieties of apples, pears, and sweet cherries. The majority of clonal apple and sweet cherry rootstocks are propagated using division methods, such as layering or scaffolding, while a smaller number are raised through cutting methods, such as root cuttings and micropropagation. Sometimes, a rootstock clone with highly desirable traits that is hard to root is employed as an interstock by grafting it between the scion and a more readily propagated rootstock clone

. **Table 1. Methods of rootstock propagation**

Plant part	Technique
Seed	Sexual Apomictic
Division	Stooling, Layering, Marcotting
Cutting	Soft wood cutting, Root cutting, Hardwood cutting, Semi-hardwood cutting, Micropropagation

PROPAGATION BY SEED

Most rootstocks for a wide variety of temperate and subtropical fruit and nut species, such as apricots, peaches, and nectarines (*Prunus persica* L.), (*Pyrus armeniaca* L.), and *Pyrus pyrifolia*, the Asian pear and citrus species are raised from seeds (Nakai). There are many benefits to seed propagation for the nurseryman; specifically, it's easier and less expensive to do than vegetative techniques. If trees were grown from seedlings, rootstocks offer any benefits to fruit growers, Nevertheless, is far less evident and frequently trees grown on seedling rootstocks are far less good than individuals using clonal rootstocks.

Seedling rootstocks may have obvious advantages in species like apples, where viruses are believed not to spread through seeds and where nurseries around the world struggle to keep virus-free clonal rootstocks healthy. Another benefit of seedling propagation is the ability to stop the spread of root-borne illnesses such crown gall (Agrobacterium tumefaciens). This problematic disease is often transferred to the new scion tree and the new site by rootstock liners from infected feces or layer beds. This issue is avoided by seedling stocks grown in soil free of crown gall.

However, there are three ways to improve the uniformity of performance of seedling rootstocks: (1) using seed from a single clonal variety (like the "Red Delicious" apple or "Bartlett" pear) or from a self-fertile cultivar grown in a monoculture; (2) using seed collected from virus-free mother orchards planted in isolation (like the Pontavium and Pontaris Prunus avium lines of Mazzard rootstocks available in France); and (3) using seed of apomictic rootstock selections.

In comparison with vegetative propagation relatively little research is now conducted into the techniques of seedling rootstock propagation for temperate fruits. The techniques of after-ripening and dormancy-breaking, essential with seed of many Rosaceae, are now well elucidated. Aids to dormancy-breaking, such as scarification, and stratification are widely adopted by commercial nurserymen. Treatment with hormones, which may also aid dormancy breaking are less frequently adopted, however. Treatment with gibberellic acid (GA3) and benzyl adenine (BA), (both at 20 mg/litre), of peach seeds which had previously been stratified at 10 and 15°C enhanced germination, whereas treatment with thiourea was ineffective in Thai trials (Siyapananont 1990). Similar results were recorded by Shatat and Sawwan (1985) who demonstrated that germination of Prunus mahaleb seed was improved significantly by treatment with Promalin (a mixture of GA4+7 and BA) at 3000 mg/litre.

STOOLING AND LAYERING

The division procedures employed in tree rootstock propagation, known as stooling or layering, were skill fully documented many years ago (Knight et al., 1927), and not much has changed in terms of how these processes are carried out since then (M AFF1969). They entail stimulating a portion of the rootstock stem to grow adventurous roots while it is still attached to the parent plant. Typically, to promote rooting, the targeted area of the stem is made darker by blanching or etiolation; this can be done with soil, another medium (such as sawdust or peat), or by covering it with an opaque material like plastic. Adequate temperatures must be combined with enough moisture and oxygen in the edaphic zone that is immediately surrounding the intended rooting zone. Stooling and stacking issues are typically caused by the above parameters not being met. Poor stool or layer bed performance is frequently caused by inadequate natural soil conditions or by using the wrong media when earthing up stools or layer beds. In many regions of the world, sawdust is frequently used to dirt up stool/layer beds; however, care must be taken to ensure that the wood species utilized contain no contaminants, either naturally occurring or introduced, that could prevent stool shoot roots. To promote stool shoot roots, some British nurserymen have added a coating of moist peat near the base of the shoots. Poor roots can also often be caused by other common issues, such as delayed earthing-up and inadequate moisture.

The use of plant growth agents to facilitate stool or layer bed proliferation has been minimal. The number of rooted shoots on stool beds of M.26 apple rootstock was found to increase in response to mid-June ethephon sprays at modest doses (300 mg/litre), according to Polish testing. Nevertheless, additional investigation conducted in Poland revealed no advantage to spraying the growth retardant Cyclocel on the layer beds or stool of the dwarfing apple rootstock clone P.2. Numerous soil-borne pests and illnesses can also harm stool and layer beds. Production is severely limited by a number of nematode species as well as by bacterial (Agrobacterium spp.) and fungal (Thielaviopsis, Phytophthora spp.) disease assaults.

PROPAGATION BY CUTTING

In rootstock propagation, two primary cutting kinds are used: summer-grown softwood and winter-grown hardwood cuttings. More and more recently, recalcitrant subjects have been propagated using another cutting technique called micropropagation, which also helps quickly multiply rootstocks that are in short supply. Semi-hardwood (greenwood) cuttings are a less common method that are occasionally used to propagate Primus rootstocks. And lastly, root cuttings are also sometimes used to propagate rootstocks. The development of effective hardwood cutting methods for apple, plum, and quince (Cydonia oblonga Mill.) rootstock clones has been a major area of research in Britain.

Three factors are essential for any kind of cutting propagation to be successful. Prior to cutting excision, the propagule needs to be healthy and in the proper physiological condition. This is accomplished by practicing good stock plant care. Secondly, in order to facilitate rooting, the cutting can require chemical or physical treatment. Lastly, the cutting needs to be put in an environment that promotes root formation, induction, and/or survival.

MICROPROPAGATION

In recent years, rootstocks have been the focus of many commercial micropropagation facilities due to their suitability as subjects for this growing field of study. Over the past ten years, numerous rootstocks have benefited from the development of new and improved micropropagation techniques. These include the apple clones M.9 (Webster and Jones 1989), M.26 (Lee et al. 1990), M.27 (Amitrani et al. 1989), and MM.lll (Arello et al. 1991), as well as pear, quince, plum, and peach rootstocks, quince, plum, and sweet cherry rootstocks and peach rootstock. The sole means of clone propagation, its application is fully warranted. The method can also be used to quickly develop novel rootstock varieties or to make it easier to transport healthy materials across national boundaries while adhering to plant importation and health standards. Recalcitrant rootstocks, including the apple clones Ottawa 3 (Pua et al. 1983) and M.9 (Webster and Jones 1989), as well as the Brossier pear rootstocks, have shown to be especially amenable to micropropagation. Not every rootstock is suitable for micropropagation. In lengthy testing conducted at East Mailing by Webster and Jones (1991), the Polish and Russian apple rootstocks, P.2 and Budagovski 9, respectively, both responded badly to the approach.

ROOTSTOCKS USED AS INTERSTOCKS

While some rootstock clones have many favorable qualities, like good control over scion vigor, resilience to winter cold injury, and good induction of cropping, they are highly challenging to root using traditional propagation methods. The apple rootstock Ottawa 3 is one instance. One workaround for such circumstances is to use micropropagation; another is to use the clone as an interstock instead of a rootstock that is simpler to root. Incompatibilities between rootstocks—such as those between many pear scions and quince rootstocks—can also be mitigated using interstocks. When trees grown directly on dwarfing clones are too weak or have root systems that are not suitable for the edaphic circumstances, dwarfing interstocks are frequently utilized to increase tree development and anchoring on marginal soils.

Regretfully, dwarfing interstocks are often far less effective when used for stone fruits, even though they have positive results when used to raise apple and pear trees. While genetic dwarf clones of Prunus avium and a clone of Prunus mugus efficiently dwarfed sweet cherry trees when used as rootstocks, their effects on tree vigor as interstocks were negligible, according to research conducted at East Mailing. Studies conducted on apples showed that the dwarfing effect increased with the length of the interstock employed when dwarfing rootstock clones were used as interstocks. This is comparable to the increased dwarfing impact that is observed when budding height increases with dwarfing rootstocks.

CONCLUSION

In conclusion, the propagation of temperate fruit tree rootstocks has evolved significantly, prioritizing traits like disease resistance, climatic adaptability, and scion dwarfing over traditional propagation ease. Advanced techniques such as micropropagation have enabled the cultivation of resistant clones, offering benefits in commercial production. However, these methods are not without challenges, including issues like increased burr knotting and excessive suckering in micro propagated rootstocks. As the field progresses, balancing the advantages of novel propagation techniques with their drawbacks will be crucial to optimizing rootstock performance and ensuring sustainable fruit production in temperate regions.

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ROLE OF ANTIBIOTICS IN PLANT DISEASE CONTROL

Sagnik Ghosh and Amitava Mondal*

Faculty of Agriculture, JIS University, Agarpara, Kolkata, West Bengal-700109, India

*Corresponding author: amitava435.am@gmail.com

ABSTRACT

Antibiotics, secondary metabolites produced by microorganisms, can inhibit or kill other microorganisms at low concentrations. Their selective action against plant pathogens, low phytotoxicity, and ability to be absorbed through foliage and translocated systemically make them effective in managing plant diseases, particularly those caused by bacteria, mycoplasma, and rickettsia. Antibiotics do not participate in primary metabolic processes such as cell wall formation or energy production. The use of antibiotic mixtures is common to prevent or delay resistance development in pathogens, enhancing their efficacy in disease management.

KEYWORDS: Antibiotics, Classification, Mechanisms, Plant diseases management

INTRODUCTION

The proliferation of plant pathogens, primarily bacterial and fungal, has necessitated an exigent intervention of antimicrobial agents, known colloquially as antibiotics, within the agronomic domain. These chemical compounds, either naturally derived from microbial entities or synthetically fabricated, serve as a bulwark against the onslaught of phytopathogens that threaten the productivity, quality, and economic viability of diverse crops (Coomes et al., 2019). The utilization of antibiotics in plant disease control, while historically overshadowed by their application in human and veterinary medicine, has emerged as a critical component of integrated plant disease management (IPDM) strategies, particularly in scenarios where conventional fungicides and bactericides fail to provide adequate protection. Plant pathogenic bacteria (PPB) cause approximately one billion dollars in crop losses annually, mostly in grapevines, pear and apple orchards, paddy along other crops across the world and also growing risks are numerous different plant diseases. The deployment of antibiotics in agriculture, however, is not without its controversies, primarily concerning the emergence of antibiotic-resistant strains of pathogens and the potential implications for human health (Chang et al., 2015). This discourse aims to elucidate the multifaceted role of antibiotics in plant disease management by exploring their classifications, mechanisms of action, efficacy against specific plant pathogens, and the commercial availability of these compounds within the Indian agricultural market. This analysis will be grounded in rigorous scientific inquiry, drawing upon contemporary research to provide a thorough understanding of the subject matter. Thus, farmers around the world frequently turn to antibiotics as a straightforward and efficient method for the management of bacterial diseases.

CLASSIFICATION OF ANTIBIOTICS USED IN PLANT DISEASE MANAGEMENT

The classification of antibiotics employed in plant disease control can be delineated based on their origin, spectrum of activity, and mechanism of action. These classifications provide a framework for understanding the diverse array of antibiotics that have been harnessed in agricultural practices (Saikia and Chetia, 2024).

1) *Origin-Based Classification:* Antibiotics utilized in plant disease management can be broadly categorized into two primary groups based on their origin:

a) **Naturally Occurring Antibiotics:** These antibiotics are derived from microorganisms, primarily bacteria and fungi, that naturally produce these compounds as a defense mechanism against competing microbial species. The majority of antibiotics used in plant disease control belong to this category, as they are often more environmentally friendly and biodegradable.

b) **Synthetic Antibiotics:** These are chemically synthesized compounds designed to mimic or enhance the activity of naturally occurring antibiotics. Synthetic antibiotics are often engineered to possess broader spectra of activity, greater stability, and improved resistance to environmental degradation.

2) Based on Spectrum of Activity:

a) **Broad-Spectrum Antibiotics:** These target a wide range of pathogens, including both Gram-positive and Gram-negative bacteria. Tetracycline is an example.

b) **Narrow-Spectrum Antibiotics:** These are effective against specific pathogens. For example, Streptomycin is primarily effective against bacterial plant pathogens like Xanthomonas spp.

3) Mode/Mechanism of Action-Based Classification

The mechanism by which antibiotics exert their antimicrobial effects can vary significantly. The primary mechanisms of action include:

a) **Inhibition of Cell Wall Synthesis:** Antibiotics such as β-lactams (e.g., penicillin) inhibit the synthesis of the bacterial cell wall, leading to cell lysis and death. This mechanism is particularly effective against Gram-positive bacteria, which possess a thick peptidoglycan layer in their cell walls.

b) **Inhibition of Protein Synthesis:** Antibiotics such as tetracyclines and aminoglycosides target the ribosomal machinery of bacteria, inhibiting protein synthesis and thereby preventing bacterial growth and proliferation.

c) **Inhibition of Nucleic Acid Synthesis:** Some antibiotics, such as fluoroquinolones, inhibit the synthesis of bacterial DNA or RNA, thereby preventing replication and transcription, which are essential for bacterial survival and growth (Bhattacharjee, 2022).

d) **Disruption of Cell Membrane Integrity:** Certain antibiotics, such as polymyxins, disrupt the integrity of the bacterial cell membrane, leading to leakage of cellular contents and cell death.

e) **Inhibition of Metabolic Pathways:** Antibiotics such as sulfonamides inhibit specific metabolic pathways essential for bacterial growth, such as the synthesis of folic acid.

MAJOR ANTIBIOTICS USED IN PLANT DISEASE MANAGEMENT

The following sections will delve into the major types of antibiotics utilized in their mechanisms of action, and their specific applications in the control of plant pathogens. Additionally, the generic and commercial names of these antibiotics in the Indian market will be provided to offer a comprehensive overview of their availability and use.

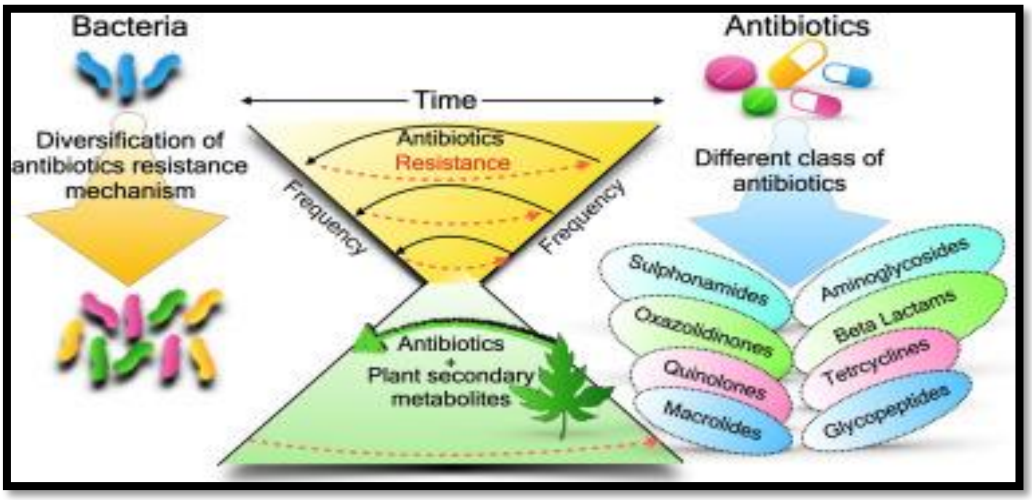

Figure 1: Development of Antibiotic Resistance Over Time

STREPTOMYCIN

Mechanism: Streptomycin, an aminoglycoside antibiotic, exerts its bactericidal effects by binding to the 30S ribosomal subunit of bacteria, thereby inhibiting protein synthesis. This binding causes misreading of mRNA, leading to the production of nonfunctional or toxic proteins, ultimately resulting in bacterial cell death.

Applications: Streptomycin is one of the most widely used antibiotics in plant disease control, particularly for the management of bacterial diseases. It is highly effective against a range of bacterial pathogens, including Erwinia amylovora (fire blight in apple and pear), Pseudomonas syringae (bacterial speck in tomato), and Xanthomonas spp. (bacterial spot in tomato and pepper).

TETRACYCLINE

Mechanism: Tetracyclines function by binding to the 30S ribosomal subunit, blocking the attachment of aminoacyl-tRNA to the ribosome, and thereby inhibiting protein synthesis. This inhibition is bacteriostatic, meaning it prevents bacterial growth rather than killing the bacteria outright.

Applications: Tetracyclines are used in the control of a variety of bacterial diseases in plants, particularly in the management of bacterial wilt (caused by Ralstonia solanacearum) and citrus greening disease (caused by Candidatus liberibacter spp.). Their use is often limited by the development of resistance in bacterial populations.

PENICILLIN

Mechanism: Penicillins, a class of β-lactam antibiotics, inhibit bacterial cell wall synthesis by binding to and inactivating penicillin-binding proteins (PBPs), which are essential for the cross-linking of peptidoglycan chains. This results in the weakening of the cell wall and eventual lysis of the bacterial cell.

Applications: While penicillins are more commonly associated with human and veterinary medicine, they have also been employed in the control of certain plant pathogens. For instance, penicillin G has been used in the control of crown gall disease caused by Agrobacterium tumefaciens.

KASUGAMYCIN

Mechanism: Kasugamycin, an aminoglycoside antibiotic, inhibits protein synthesis by binding to the 16S rRNA of the 30S ribosomal subunit. Unlike other aminoglycosides, kasugamycin prevents the initiation of translation by interfering with the mRNA-tRNA interaction, rather than causing a misreading of mRNA.

Applications: Kasugamycin is primarily used in the control of bacterial diseases in rice, such as rice bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae*. It has also shown efficacy against other bacterial diseases in crops such as vegetables and fruit trees.

BLASTICIDIN-S

Mechanism: Blasticidin-S is a nucleoside antibiotic that inhibits protein synthesis by binding to the peptidyl transferase centre of the 50S ribosomal subunit, thereby preventing the elongation of the polypeptide chain during translation.

Applications: Blasticidin-S is primarily used in the control of rice blast disease caused by *Magnaporthe oryzae*, one of the most devastating fungal diseases affecting rice crops. Its use is often combined with other fungicides to enhance efficacy and reduce the development of resistance.

VALIDAMYCIN

Mechanism: Validamycin is a member of the aminoglycoside class of antibiotics that inhibits trehalase, an enzyme crucial for the hydrolysis of trehalose into glucose, which is essential for fungal growth. This inhibition disrupts the energy metabolism of the fungus, leading to its death.

Applications: Validamycin is widely used in the control of fungal diseases in crops such as rice, potatoes, and vegetables. It is particularly effective against rice sheath blight and potato black scurf caused by *Rhizoctonia solani* (Taheri and Tarighi, 2011).

POLYOXINS

Mechanism: Polyoxins are a group of nucleoside antibiotics that inhibit chitin synthase, an enzyme involved in the synthesis of chitin, a major component of fungal cell walls. By disrupting chitin synthesis, polyoxins weaken the structural integrity of the fungal cell wall, leading to cell lysis and death.

Applications: Polyoxins are used in the control of various fungal diseases in crops such as vegetables, fruits, and ornamentals. They are particularly effective against powdery mildew, downy mildew, and other foliar fungal pathogens.

CONCLUSION

The role of antibiotics in plant disease control is both critical and complex, involving a delicate balance between efficacy in controlling phytopathogens and the risk of resistance development. The diverse array of antibiotics, each with its unique mechanism of action and spectrum of activity, provides a robust arsenal for the protection of crops against bacterial and fungal diseases. However, the judicious use of these compounds, informed by scientific research and integrated pest and disease management principles, is essential to ensure their continued effectiveness and to safeguard both plant health and human health. The commercial availability of these antibiotics in the Indian market underscores their importance in agricultural practices, while also highlighting the need for responsible stewardship to prevent the erosion of their utility.

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LIQUID ORGANIC FORMULATIONS

Shivangi Kaith, and Devendra Kumar Dadhich*

Agronomy Section, ICAR- National Dairy Research Institute, Karnal- 132001

*Corresponding author: devdadhich098@gmail.com

ABSTRACT

Organic formulations offer a sustainable alternative to chemical fertilizers and pesticides, preserving soil health and promoting organic matter recycling. These formulations enhance crop growth by improving physiological and biochemical processes in plants, providing essential nutrients, growth regulators, and other beneficial compounds. Their use increases crop resilience to biotic and abiotic stresses while fostering beneficial soil microflora that boosts nutrient availability. Moreover, liquid organic formulations are cost-effective and can be easily produced by farmers using locally available materials, supporting eco-friendly agricultural practices. This approach aligns with sustainable farming, reducing dependency on synthetic agrochemicals.

KEYWORDS: Jeevamrita, Matka Khad, Organic formulations, Vermiwash

INTRODUCTION

Currently, the escalating global population is placing significant demands on agriculture to fulfill the increasing need for nutritional food. To meet the current food demand, farmers are increasingly turning to chemical fertilizers to enhance productivity per unit area. Nevertheless, the overuse of these fertilizers has led to a plateau in their effectiveness, causing a decline in soil fertility across agricultural fields and the accumulation of harmful substances in harvested crops. In this context, it is crucial to identify cost-effective and environmentally friendly alternatives to chemical fertilizers. Organic farming is a method of production that relies on practices like crop rotation, green manure, vermicompost and biofertilizers. The application of liquid organic manures not only contributes to increased crop yields but also represents a cost-effective production method, enabling farmers to attain higher returns (Devakumar et al., 2014). Application of these organic manures also enhances the microbial population in soil and their activity to a greater extent and has positive effect on growth and development of crop. These formulations often involve organic inputs and are preferred for their ease of application, rapid absorption by plants, and versatility in addressing specific agricultural needs (Yadav et al., 2023). They are commonly used to enhance soil fertility, provide essential nutrients to crops and manage pests in an eco-friendly manner.

LIQUID FORMULATIONS

An organic compound-based product that is liquid in nature is referred to as a liquid organic formulation. Carbon-based substances that come from living things or their waste products are known as organic compounds. These liquids are frequently made in the context of formulations by mixing or blending various organic ingredients to accomplish particular qualities or purposes. These are used for different purposes such as nutrient suppliers, insect controllers, growth promoters etc. Based on their uses some liquid formulations are given below with their preparation techniques:

1. MATKA KHAD:

A natural fertilizer named "earthen pot manure" or "matka khad" is produced through the decomposition of a blend of soil, cow dung, and kitchen waste within a permeable earthen pot.

Materials required: For preparing 20 L pitcher we need: -

Cow Dung (5 kg), Cow Urine (5 L), Water (5 L), Jaggery (250 g)

Preparation technique: Blend the necessary ingredients thoroughly and pour the mixture into a pitcher. Bury the pitcher in the soil, ensuring that its upper part/neck is exposed above the ground surface. Cover the mouth with the lid. Matka khad will be ready for use after 8-12 days. Dilute it with 7-8 liters of water and apply it using a pump or broom (without sieving) twice in the field (15 days before and 15 days after sowing).

2. VERMIWASH:

This organic fertilizer is derived from drainage-oriented vermiculture and vermicompost setups, boasting a high concentration of dissolved minerals and easily absorbable amino acids for plants. Functioning as a non-toxic and environmentally friendly substance, vermiwash acts as a protective barrier, impeding bacterial growth and promoting the overall health and growth of earthworms. Diluting vermiwash at a 5–10 percent concentration effectively hinders the mycelial development of detrimental fungi (Das et al., 2014).

Materials required: For preparing 20 L pitcher we need: -

3 pitchers, 2 lids, Rope (4 m), Thin rubber pipe (1.5 m), Cow dung (4 kg), Biomass (2 kg), Adult earthworms (200-300 no.).

Preparation technique: Puncture a hole in a pitcher and attach a rubber pipe. Place a few pebbles at the bottom of the pitcher, followed by a 2–3 inches layer of sand. Above this, create a layer (5-10 cm) using dry biomass. On top of this layer, add a 10cm thick layer of 15-20 days old cow dung. Once the material fills up to 2/3rd of the pitcher, introduce 200-300 adult earthworms. Cover them with a little biomass and sprinkle some water. Hang the pitcher using a plastic rope on a tree or in a shaded area. Position another pitcher above, filled with water and a hole at the bottom, allowing water to drip down into the pitcher with earthworms. Connect the earthworm-containing pitcher to an empty pitcher below with a plastic pipe to collect vermiwash. After diluting the collected vermiwash with water in a 1:10 ratio, spray it at different crop stages with a 15–20 days interval.

Figure 1: Matka Khad

Figure 2: Vermiwash

3. JEEVAMRITA:

Jeevamrita is an organic liquid fertilizer composed of urine, cow dung and other plant-based materials that have been fermented. It is abundant in nutrients and healthy microbes. In organic farming, Jeevamrita is used to encourage plant development, increase soil fertility and maintain overall soil health.

Materials required:

Cow dung (1 kg), Cow Urine (1 L), Jaggery (200 g), Gram Flour (200 g), Fertile soil (100 g) and

Water (20 L)

Preparation technique: Mix the above said ingredients with water and stir it with a wooden stick three time daily for 5-7 days. Sprinkle Jeevamrita on to the soil or mix it with irrigation water. Spray Jeevamrita once before sowing, after 20 and 45 days of sowing for better results.

4. Bijamrita:

It is a mixture crafted from neem leaves, pulp, tobacco and green chillies, prepared for insect and pest control and suitable for seed treatment. Cow dung contains naturally occurring beneficial microorganisms, which are cultured into bijamrita and applied to seeds as an inoculant. The use of bijamrita in seed treatment is known to safeguard crops from detrimental soil-borne pathogens and is also beneficial in the production of IAA and GA3, hormones promoting plant growth (Kantwa et al., 2022).

Materials required:

Cow dung (1 kg), Cow Urine (1 L), Cow Milk (0.2 L), Slaked lime (250 g), Water (20 L)

Preparation technique: Combine all ingredients in water and let the solution stand overnight. Prior to sowing, apply 100 ml of beejamrit to 1 kg of seeds and allow them to dry in the shade. Alternatively, seeds can be treated by blending beejamrit with biofertilizers.

5. PANCHGAVYA:

The term 'Panchgavya' originates from the combination of 'Panch' meaning five and 'gavya' derived from 'Gau' which refers to a cow. Collectively, it signifies five products obtained from a cow. It is a vital organic fertilizer in organic farming, replacing harmful synthetic chemicals. It's a cost-effective and beneficial option, enhancing soil fertility, improving earthworm quality and promoting crop health (Bajaj et al., 2022).

Materials required:

Fresh cow dung (5 kg), Cow urine (3 L), Cow milk (2 L), Curd (1 L), Desi ghee (1 kg)

Preparation technique: Thoroughly mix the necessary ingredients and cover the mixture for 7 days in a suitable container placed in a shaded area. Stir the material 2-3 times a day. For soil treatment, dilute 5 L of panchgvya with 25 L of water. This mixture can also be utilized for seed treatment and as a spray. For insect and disease control, dilute 5 L of panchgvya with 50 L of water.


Figure 3: Jeevamrita


Figure 4: Bijamrita

CONCLUSION

The utilization of liquid organic formulations is essential for sustaining soil health, as they contribute to increased availability of nutrients and the growth of beneficial microbial populations. This practice serves as an alternative to dependence on chemical fertilizers, pesticides and other agro-chemicals providing a sustainable means to support and enhance crop productivity in agriculture.

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UNLOCKING THE UNCHARTED USES OF THE PHENOMENAL *Syzygium cumini*

Darshini Srinivasan*

National Institute of Food Technology Entrepreneurship and Management (NIFTEM-T), Thanjavur-613005, India

*Corresponding author: darshivasan@gmail.com

ABSTRACT

Syzygium cumini, commonly known as Jamun or black plum, is an indigenous Indian fruit with numerous health benefits. Rich in antioxidants, flavonoids, polyphenols, iron, and vitamin C, this tropical evergreen plant from the Myrtaceae family has been used in traditional medicine for centuries. Jamun has been employed to treat various ailments, including metabolic conditions such as obesity, diabetes, hypertension, and hyperlipidemia. Despite its potential, the fruit's benefits remain largely untapped. This essay explores the nutritional value of Jamun and highlights its potential in combating metabolic syndromes.

KEYWORDS: Food industry Morphology, Nutrition, Therapeutics

INTRODUCTION

A priceless medicinal plant belonging to the Myrtaceae family, the Jamun tree has long been used in traditional Indian and worldwide medicine. This is a vital medicinal plant and an evergreen flowering plant that has historically been used to treat a wide range of illnesses in tropical areas of Bangladeshi, Sri Lankan, Indian, and Pakistani healthcare systems (Sagar and Dubey, 2019). Its seeds, commonly referred to as "Maghz-e-Jamun or Tukhm-e-Jamun," have the ability to lower blood sugar levels in people with intermediate hyperglycemia. It is anticipated that 13.5 million tons of jamun will be produced worldwide, with 15.4% coming from India (Kshirsagar et al., 2019).

GROWTH CONDITIONS AND MORPHOLOGY

In semi-arid subtropical climates with 350–500 mm of annual precipitation, it can be grown with success. It can also be seen growing up to 1300 meters in altitude in the lower Himalayan regions. It can be cultivated in wasteland, resource-poor, arid, and semiarid regions where other crops are hard to produce. It may be grown in ravines and degraded areas and can withstand salinity and sodic soils.

According to reports, plants can thrive on alkaline soils with a pH of up to 10.5. The plant should be generally avoided planting in areas of heavy rain (Prakash Tripathi, 2020).

Figure 1. *Syzygium cumini* (a) Fruits (b) Seeds

Jamun is also referred to as java plum or black plum. With white branch tips and reddish-brown juvenile shoots that grow to a height of 8 to 15 meters, Jamun is a silky smooth, well-developed tree. The opposite, glossy, leathery leaves have a broad, sharp tip and are obovate to oval or obovate-elliptic, measuring 6 to 12 cm in length (Kumar and Singh, 2021). The fruit's rich purple color and the seed's range of white to pink were among its physical attributes. According to reports, the Jamun fruit and seed measured 31 and 18.20 mm in length, 28.7 and 11.05 mm in width, and 18.32 and 1.62 g in weight (Kshirsagar et al., 2019).

NUTRITIONAL COMPOSITION

Jamun's chemical composition includes 1.02 mg of crude fat (1.18–4.50%), 3.84 to 7.17 mg of crude protein (6.3–8.5%), 22.8 g to 31.6 g (41%), 7.01 mg of crude fiber (2.64–16.9%), 0.6 mg of calcium (0.41%), and 0.072 mg of phosphorus (0.17%) (Kshirsagar et al., 2019) (Binita et al., 2017). Further, Table 1 showed the phytochemical present in different parts of Jamun.

Table 2. Phytochemicals present in Jamun fruit (Ramteke et al., 2015)

Plant part	Chemicals present
Seeds	Jambosine, gallic acid, ellagic acid
Stem bark	Friedelin, betulinic acid, kaempferol
Flowers	Quercetin, oleanolic acid, myricetin
Fruit pulp	Petunidin, anthocyanin, delphinidin
Leaves	Crategolic acid, n-hepatcosane, n-triacontanol
Essential oils	Eucarvone, muurolol, 8-cineole

PHARMACOLOGICAL AND THERAPEUTIC ACTIVITIES

According to the Unani medical system, jamun has a variety of pharmacological properties, including astringent, hemostatic, antidiabetic, urinary incontinence, and sexual tonic properties. (Rather et al., 2019). Its properties include being astringent, carminative, stomachic, diuretic, antidiabetic, anti-inflammatory, anti-radiation, gastroprotective, antioxidant, anti-allergic, antibacterial, anticancer, and cardioprotective. Glycosides, fat, resin, albumin, chlorophyll, gallic acid, 1-galloylglucose, 3-galloylglucose, quercetin, and metals including zinc, chromium, vanadium, potassium, and sodium are produced by the variety of chemical components found in seeds (Kumar and Singh, 2021).

Its fruit and leaves are beneficial to those with diabetes. It relieves the symptoms of diabetes, like pushing and frequent urination. For the treatment, the bark, seeds, and leaves extracts work incredibly well (Joshi et al., 2019). It's associated with numerous micro- and macrovascular issues. (Parveen et al., 2020). It can even aid in the treatment of liver and cardiac issues. It is a good source of ascorbic acid and iron. In India, the dried and powdered jamun seed is widely used to treat diabetes (Sagar and Dubey, 2019). Jamun seed powder has long been used as a home remedy for digestive and cardiovascular issues, as well as a natural means of preserving a healthy blood sugar level (Sood et al., 2018). Jamun is one of the most nutrient-dense and perishable tiny fruits. Numerous anthocyanins found in it have anti-analgesic properties (Ghosh et al., 2017)

APPLICATIONS IN FOOD INDUSTRY

The jamun fruit is rich in nutrients and has multiple applications, utilizing every part of the tree. The taste of jamun fruit is peppery and sub-acid, and squash makes a wonderfully cool beverage (Prakash Tripathi, 2020). Premium jamun juice works wonders for "squash," syrup, and sherbet. The latter is a bottled beverage made in India that is made by heating crushed fruits to 140°F for five to ten minutes, then pressing off the juice and mixing it with water and sugar. Sodium benzoate and citric acid are then added as preservatives. Ripe fruits are used to make wine, preserves, squash, jellies, and health beverages. If not cooked for a short time, the white-fleshed jamun has enough pectin to produce an extremely stiff jelly (Ramteke et al., 2015).

CONCLUSION

Significant amounts of antioxidants, polyphenols, flavonoids, minerals, vitamins, and phytochemicals can be found in the peel, pulp, and seed of the jamun. Several investigations demonstrate the pharmacological relationship between metabolic problems and jamun. Traditionally, jamun has been used to treat a wide range of illnesses, most notably diabetes and its consequences. Studies pertaining to Jamun's antineoplastic properties indicate that it acts specifically on breast cancer cells. The jamun plant, particularly its fruit and seeds, has been shown to have major health benefits in a number of research that were included in this study. Thus, it's critical to encourage this medicinal plant's wider agricultural and industrial development and to start campaigns to raise public awareness of its health benefits. Novel concepts regarding its routine ingestion are still sought, as they could augment the assimilation of multiple noteworthy bioactive constituents from jamun to combat diverse ailments. The health advantages of jamun should be promoted to urban populations through both raw and value-added products, with a particular focus on supporting Indian tribal communities' jamun growers.

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UNVEILING THE POTENTIAL OF UNDERUTILIZED TUBER CROPS: HEALTH BENEFITS AND NUTRITIONAL POTENTIAL

Ramakrishna, A.*

Division of Food Science and Post Harvest Technology, ICAR-Indian Agricultural Research Institute, New Delhi (110012), India

*Corresponding author: ramakrishna.addagada7@gmail.com

ABSTRACT

Despite their nutritional benefits, tuber crops remain underutilized worldwide. In tribal areas, these crops are vital for food and nutritional security, offering a diverse range of energy, minerals, and vitamins. Out of 30,000 edible plant species, 30 provide 90% of human calories. Tuber crops, rich in energy, fiber, calcium, iron, and vitamins, are crucial in tribal diets. Processing these crops can enhance food security and health. Additionally, tubers, often associated with poverty, have market potential in the developed world as frozen goods, chips, and flour. Their stress tolerance and efficiency in marginal soils make them increasingly important for regional food security.

KEYWORDS: Cassava, Health benefits, Sweet potato, Tuber crops, Yams

INTRODUCTION

Among all crops, tuber crops exhibit the highest rate of dry matter production per day per unit area and the highest biological efficiency. Roots and tubers are recognised globally as significant food components with immense potential, chief among them being the ability to provide food security to countless millions of people with inadequate resources. Both the food security of tribal groups and the diets of small and marginal farmers depend heavily on tuber crops. In addition to offering dietary diversity, tuber crops possess therapeutic properties that aid in the treatment or avoidance of numerous ailments. India's genetically diversified tropical root and tuber crops include aroids, cassava, sweet potato, yams and other minor tuber crops which are used to make stimulants, tonics, carminatives, and expectorants, a range of tropical tuber crops are used. Tuber crops are rich in dietary fibre and carotenoids including anthocyanin and beta-carotene. In addition to tubers Numerous nutritional and physiological advantages are provided by these crops, such as antimicrobial, hypoglycemic, hypocholesterolemic which that modulate immunity.

TROPICAL TUBER CROPS

1. AROIDS

Taro (Colocasia), gigantic taro (Alocasia), elephant foot yam (Amorphophallus), tannia (Xanthosoma), and swamp taro are tuber-bearing plants in the Araceae family (Cyrtosperma). A staple food in many African nations is colocasia. Aroids can be used to make flour. They have readily digested fine starch in them. Growing taro in the South Pacific is often advised for all newborns, especially allergy-prone ones, as a weaning diet. These rhizomes have various beneficial components that are used in the food sector, such as starch, mucilage, and powders. Their ability to function as a thickening and gelling agent has led to their application in baked goods, culinary pastes, and drinks. (Calle et al. 2021).

Elephant foot yam

Colocasia

2. CASSAVA

The Euphorbiaceae family includes the cassava (Manihot esculenta Crantz), which is thought to have originated in South America, most likely Brazil. Over 500 million people worldwide depend on cassava as a major source of carbohydrates due to its high content Cassava roots contain a variety of compounds, including terpenoids, flavonoids, hydroxycoumarins such scopoletin, non-cyanogenic glucosides, linamarin, and lotaustralin. Before being ground into flour for bread and fufu, the roots are fermented and dried. Grated fermented roots are combined with water, filtered, and then the starch is let to settle to produce starch. Starch can then be used to make tapioca. It's possible to have white or yellowish flesh. In addition to having a high starch content, cassava roots also contain substantial amounts of calcium (50 mg/100 g), phosphorus (40 mg/100 g), and vitamin C (25 mg/100 g). However, they lack some minerals and protein. Conversely, cassava leaves offer a respectable amount of protein; they are low in tryptophan and methionine but high in lysine.

Cassava tuber

3. SWEET POTATO

The Convolvulaceae family includes the domesticated sweet potato (Ipomoea batatas L.) and closely related wild species in the genus Ipomoea and subgenus Eriospermum. Grown in warm temperate, tropical, and subtropical climates, it is the seventh greatest food crop in the world. When the weather conditions are suitable, sweet potatoes can be produced all year round. Because complete crop failure as a result of unfavourable weather is rare; for this reason, it is known as a "insurance crop." The National Aeronautics and Space Administration (NASA) has selected sweet potatoes as a possible crop to be cultivated and used in astronaut meals on space missions due to their special qualities and nutritional value. In India, sweet potatoes are eaten in large quantities after being boiled, baked, or fried; in other countries, sweet potato flour is frequently used in cakes, biscuits, and puddings. Processing sweet potato tubers increases availability and reduces waste after harvest (Kulshrestha et al. 2018). Sweet potato flour, granules, and canned sweet potatoes are among the processed sweet potato goods. In addition to having a high calorie content, it is a good source of dietary protein, vitamins (B complex, vitamin C, and beta carotene), minerals, and trace elements (Kulshrestha et al. 2018).

Sweet potato

4. YAMS

Yams are monocotyledonous plants in the Dioscoreaceae family, which includes them as staple foods in tropical climates of the approximately 600 varieties of yams, six have major social and economic value as resources for food, cash, and healthcare. yams are said to have originated in Africa, Southeast Asia, and South America three tropical regions. Yams are usually served boiling, mashed, or in bits. In soups and stews, yam is usually used in chunks; mashed yam can be used as a thickening or cooked, then fried to make cakes. Yam tubers include vitamins including tocopherols and carotenoids as well as bioactive substances like mucin, dioscin, choline, polyphenols, and diosgenin. Healthy eyes, skin, hair, and bones are facilitated by the high concentrations of protein, fat, carbohydrate, calcium, phosphate, iron, and vitamin A found in yams. According to Ray (2015), pickles, deep-fried chips, cookies, roasted cubes, Payasam, Vada, Chutney, Cutlet, and Pakoda are some of the most popular yam value-added products among processors.

Yam tuber

NUTRITIONAL IMPORTANCE OF TUBER CROPS

People who eat cassava, sweet potatoes, yams, and aroids can readily cure the nutritional deficiencies, which are rich in Vitamin A, Vitamin C, calcium, and minerals. Tubers from cassava plays an important role in health aspects because of their high carbohydrate content, ascorbic acid (Vitamin C), and a few bioactive substances like hydroxycoumarins, non-cyanogenic glucosides, and cyanogenic glucosides, they play an essential function as a staple meal. B-carotene, ascorbic acid (Vitamin C), tocopherol (Vitamin E), dietary fibre, minerals, and bioactive substances including phenolic acids and anthocyanins—which also contribute to the development of the flesh's color—are significantly concentrated in sweet potato tubers, which have orange and purple flesh. The high concentrations of proteins, lipids, minerals, fibre, carbs, and other beneficial ingredients found in yam and aroid tubers make them highly valued. Because these crops are accessible to the impoverished, it is easy to establish the nutritional balance.

Food and Nutritional security

IFPRI's July 1999 IMPACT predictions indicate that there may be a rise in the global market for roots and tuber crops 37 percent from 1995 to 2020. It is anticipated that global demand for sweet potatoes and yams would rise by 30%, and cassava and other minor roots and tubers will rise by 49%. "Food security exists when all people, at all times, have physical, social, and economic access to sufficient safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life," the World Food Summit (1996) declared. This emphasises the interdependence of the terms "food security" and "nutritional security." Numerous nutritional conditions caused by insufficient amounts of calcium, vitamin C, and vitamin A could be readily treated by intake of root and tuber crops, such as aroids, sweet potatoes, cassava, and yams. Minerals and vitamins abound in root and tuber crops . While cereal-based meals which does not include vitamin C, ascorbic acid (found in cassava and sweet potatoes) and cooked yams comprise roughly 2% protein on average. Important amino acids are also present in sweet potatoes, although lysine is lacking in rice. Sweet potato roots and green tops with orange and yellow flesh are a strong source of vitamin A, which can help avoid night blindness and malnutrition.

Additionally, sweet potatoes are a great source of antioxidant-rich nutrients such as B-carotene, ascorbic acid (Vitamin C), and tocoferol (Vitamin E), which can help prevent cancer and coronary heart disease. The recommended dietary allowance (RDA) is 500 grams per head per day for root and tuber crops, which may be sufficient to meet this requirement.

CONCLUSION

Roots and tubers are a staple of the human diet and are recognised globally as having enormous potential, chief among them being the promise to provide food security to countless millions of underprivileged individuals with few resources. Even though these crops are typically linked to poverty, the poor are not the only people who can benefit from them. Tubers can be used as functional foods and ingredients in nutraceuticals to preserve wellbeing and lessen the effects of chronic noncommunicable diseases. However, Due to this, study on root crops is lacking in order to fully use their potential benefits, which have been shown to extend beyond the conventional and include use as a source for medicinal cures, among other things.

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